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A SUSPECTED NOVA IN N. G. C. 2841

A photograph, with an exposure of two hours, made at the 25-foot focus of the 60-inch reflector on February 19, 1912, shows a relatively bright nebulous star in the spiral nebula N. G. C. 2841 that does not appear on earlier and later plates made at the Lick Observatory. The object is approximately 50″ west and 20″ north of the nucleus of the spiral; it is shown distinctly in the reproduction in the *Astrophysical Journal, 46,* Plate V a, 1917 (*Mt. Wilson Contr.*, No. 132). Professor Curtis independently found the star from an examination of the published photographs. He writes that on plates made with the Crossley reflector on April 17, 1901 (reproduced in *Lick Publication, 8,* Plate 19), and November 19, 1914, no trace of the star is seen. Observations will be continued when the spiral comes into position again.

FRANCIS G. PEASE.

A FAINT NOVA IN THE ANDROMEDA NEBULA.

Two photographs made with the 60-inch reflector on Sept. 11, 1917, show a new star of magnitude 17.5 at a distance of 10′ from the center of the Andromeda Nebula (N. G. C. 224.) The approximate position with respect to the nucleus of the nebula is

$$\Delta\alpha = +360''; \qquad \Delta\delta = +480''$$

An eighteenth magnitude companion is south 5″ and west 2″.

The star does not appear on a plate made by Mr. Pease August 21, 1917, and at that time must have been fainter than magnitude 19. No trace of it is found on any of the plates of longer exposure listed by Mr. Ritchey in a preceding note. A photograph kindly made by Mr. Ritchey on Sept. 17, 1917, for the purpose of confirmation, shows the star to have decreased about half a magnitude in six days.

HARLOW SHAPLEY.

NOTE ON THE MAGNITUDES OF NOVAE IN SPIRAL NEBULAE.

Since Ritchey's discovery of the nova in N. G. C. 6946, the number of temporary stars known to have occurred in nebulae has increased so rapidly that an opportunity is afforded of making preliminary use of relative magnitudes in estimating the order of the distances of spiral systems. The results can hope only to be suggestive, but any data will be welcome that bear directly on the problem of the distances and sizes of spiral nebulae and their relation to the galactic system of stars.

A list of the novae in spirals is given in the accompanying table. Six of the objects are situated in spiral arms, three in denser nuclear parts, and the other two apparently at some distance from nebulosity, but longer exposures would perhaps show connecting spiral arms. All but the last two of the eleven new stars seem to have completely vanished; but it is now safe to predict that the discovery of such objects in the future will be of frequent occurrence, and probably occasional ones will be suitable for more extensive spectroscopic studies. The first two in the table are S *Andromedae* and Z *Centauri*, respectively, which apparently are the only novae in spirals definitely recognized until two months ago. The third, seventh and eighth are found on only one plate each, and are missing from earlier and later negatives. Their authenticity can hardly be doubted, but there is little probability that a verification will ever be made. On the basis of chance, Curtis has noted the impossibility of considering these novae physically unrelated to the spirals with which they are associated. If further support of this conclusion were needed it could be obtained from the third column of the table, which gives the distance from the galaxy of the seven spirals in which new stars have appeared. All novae outside of spirals, with the exception of T *Coronae*, are closely confined to the Milky Way.

A LIST OF TEMPORARY STARS IN SPIRAL NEBULAE.

No.	N. G. C.	Galactic Latitude	Observed Maximum	Date of Observed Maximum	Distance from Nucleus	Discoverer
1	224	−20°	7.^{m}	Aug. 1885	16″	Hartwig[1]
2	5253	+30	7.	July 1895	32	Mrs. Fleming
3	4321	+77	13.5	Mar. 1901	110	Curtis
4	3147	+40	13-14	Apr. 1904	340	Mrs. Isaac Roberts
5	224	−20	16.3	Sept. 1909	249	Ritchey
6	224	−20	17.0	Sept. 1909	198	Ritchey
7	2841	+45	16	Feb. 1912	54	Pease
8	4321	+77	14	Mar. 1914	111	Curtis
9	4527	+64	14	Mar. 1915	45	Curtis
10	6946	+12	14.6	July 1917	111	Ritchey
11	224	−20	17.5	Sept. 1917	600	Shapley

[1] Probably first seen by Ward.

Thirty isolated novae are on record, half of which have been discovered by photography within the last 25 years. The magnitude at maximum ranges from −5 to +10, with an average of

+5.5. It depends of course on the distances of the stars as well as their luminosities; in many cases the actual maximum was probably unobserved. Further, there is some uncertainty in the estimates, and a possibility of a marked prejudice in favor of the brighter objects.

The mean observed magnitude at maximum of the eleven temporary stars in spirals is +14, with considerable uncertainty in the individual estimates, but probably with fair accuracy in the mean. Here there has been a similar but much greater selection of novae intrinsically bright, as well as a favoring of spirals relatively near. To estimate a correction is as yet difficult, if not impossible, so the magnitudes are used as they stand.

Taking the averages as referring to objects of similar luminosity, possibly an uncertain procedure because of the great dispersion in absolute magnitude of the novae in the Andromedae nebula, and probably in the galaxy as well, we observe that the difference in apparent brightness calls for a distance at least 50 times as great for these larger spiral nebulae as for the average novae of the galactic system. Concerning the parallaxes of the latter we know practically nothing, except that they are probably very small. They must be, on the average, of the order of $0''.001$ (corresponding to three or four times the distance of the B-type stars of the same apparent magnitude), or even less, if, with the above criterion, the spiral nebulae are to be well outside of our galaxy.

A few points bearing on the distance problem may be mentioned in this connection.

1. The permanent stars in the vicinity of the spirals are almost certainly not connected with the nebulae. They are generally believed to be members of the galactic system seen in projection; counts of the relative frequency of stars in and near the spirals strongly support this view. The differentiated parts of spiral nebulae are the nebulous condensations—objects with measurable angular dimensions. If we are to believe that a spiral nebula, N. G. C. 224 for instance, is a remote stellar system, its most luminous stars must be fainter than magnitude 21, since even in its thinner parts there is no hint of resolution into distinct stars on the best of plates; nor can the nebulous condensations, with magnitudes between 15 and 20, be considered an accumulation of stars brighter than magnitude 21. This point is important, for,

if in the hypothetical galactic system the brightest stars are comparable with the bright stars of our own galaxy, the minimum distance of the Andromeda Nebula must be of the order of a million light-years. At that remote distance the diameter of this largest of spirals would be about 50,000 light-years—a value that now appears most probable as a minimum for our galactic system. The same argument holds as well for other spirals, tho in some the condensations are brighter and more star-like.

2. The matter of special interest, however, in direct connection with the novae (if spirals are galactic systems of typical stars) is that these new stars attain a most extraordinary absolute brightness. The average for the eleven given in the table is at least magnitude -7, and the maximum for S *Andromedae* is at least -15—a luminosity nearly a hundred million times that of our Sun, the equivalent of the light emission of a million stars of zero absolute magnitude, and probably, therefore, much greater than the total light of all the stars seen with the naked eye.

This remarkable result must inevitably follow if spiral nebulae are considered external galactic systems comparable with our own in size and constituency. Yet, to parallel this luminosity in our own galaxy, it is only necessary to suppose that one of the brightest of the isolated new stars, *Nova Persei*, for instance, is as distant as some parts of the galactic clouds.

3. For dimensions comparable with the galactic system a spiral nebula of $5'$ apparent diameter must have a parallax less than one ten-millionth of a second of arc; and, with no extinction of light in space, a star in it of the brightness of the Sun would be fainter than the thirty-fifth magnitude. Messier 101, for instance, to be comparable must not be nearer than five million light-years; and the difficulty is obvious in reconciling van Maanen's measures of internal proper motion with the hypothesis of external galactic systems. We are not prepared to accept velocities of rotation of the order of the velocity of light. If we assume the dimensions to be one four-hundredth the minimum value adopted for our system, so that measured internal velocities are about 1000 km/sec, the distance of Messier 101 would be 32,000 light-years and any star of the absolute magnitude of the Sun or brighter could be easily photographed as a distinct stellar point. Measurable internal proper motions, therefore, can not well be harmonized with "island universes" of whatever size, if they are composed of normal stars.

4. A typical globular cluster at a distance of 30,000 light-years has an angular diameter of about 5′. Suppose it placed in a spiral nebula that is assumed to be at a distance 100 times as great. Then its integrated magnitude of 18 to 20, its diffuse outline, and its apparent diameter of 3″ would simulate very well the small nebulous condensations of spirals. The Magellanic Clouds, if located in the same nebula, would show very irregular outlines, would subtend mean diameters of approximately 30″ and 100″, and, because of their bright-line nebulae, might appear blue compared with the solar type nucleus.

Harlow Shapley.

Note on The Spectrum of Nova Persei, No. 2.

The spectrum of *Nova Persei* No. 2 was photographed on September 10, 1914, with the slitless quartz spectrograph attached to the Crossley reflector. The record, which is faint, shows a continuous spectrum extending with great uniformity far into the ultra violet. There are four weak and comparatively broad emission bands corresponding roughly in position with $H\delta$, $H\gamma$, $H\beta$ and $\lambda\ 469\mu\mu$, the latter being the brightest. The spectrum being without comparison the positions of these bands can not be determined with certainty, but there is little reason to question the identities suggested.

W. H. Wright.

Note on the Binary Star β 1026.

In 1888 Burnham found the 6.5 magnitude star in R. A. $0^h\ 6^m\ 53^s$; Decl. $+53^\circ\ 4'$ (1900.0) to be double, the two components being of equal brightness. His measures on 4 nights gave the relative position as

1888.76 329°.6 0″.48.

Measures in the next 17 years showed slow direct orbital motion, but in recent years it has been increasing and the star at present is a very difficult one to measure. This is shown by the following measures, made with the 36-inch refractor:

1914.67	27°.2	0″.17	3 nights.
1917.70	57°.2	0″.14	2 nights.

It is possible that the period may prove to be comparatively short.

Robert G. Aitken.

September, 1917.